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(54) **COMPRESSOR INLET ADJUSTMENT MECHANISM**

(57) The present invention relates to an adjustment mechanism (10) for variably adjusting the cross-section of a compressor inlet (312) . The adjustment mechanism comprises a plurality of rotatable orifice elements (100,100') and a transmission ring (210) . Each orifice element has a plate body (130) , a coupling element (110) and a bearing pin (120,120') . The transmission ring is mechanically coupled to the plurality of orifice elements via the coupling elements. One of the orifice elements is configured as a drive orifice element. The bearing pin of the drive orifice element is configured as an elongated bearing pin (120') . The elongated bearing pin is configured longer than the bearing pins of the other orifice elements. Furthermore, the elongated bearing pin is adapted to be coupled to an actuation system (230) such that when the drive orifice element is moved by the actuation system, movement is transmitted from the drive orifice element via the transmission ring to the other orifice elements.

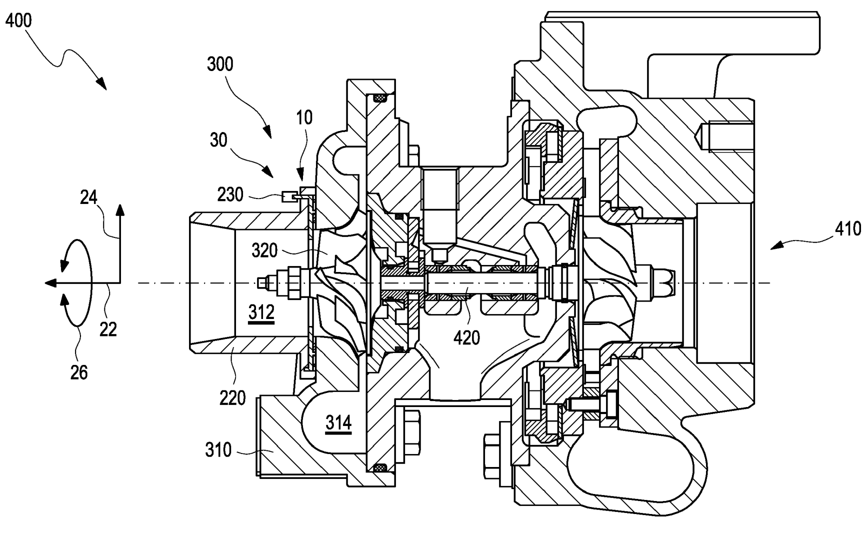

Fig. 1

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Description

Technical Field

[0001] This disclosure relates to an adjustment mechanism for adjusting the cross-section of a compressor inlet. Furthermore, the invention relates to an adjustment assembly, a compressor and a charging apparatus having such an adjustment mechanism.

Background

[0002] The individual mobility sector is experiencing a disruptive change. Especially, the increasing number of electric vehicles entering the market and stricter emission regulations of legislators demand higher efficiencies from traditional internal combustion engine ICE vehicles. Therefore, more and more vehicles are equipped with efficiency increasing measures, such as charging apparatuses and emission reduction devices. Well known are, for instance, charging apparatuses wherein a compressor may be driven by an e-motor (e-charger) and/or an exhaust gas powered turbine (turbocharger).

[0003] Common compressors thereby comprise a compressor housing and a compressor wheel which is arranged in the housing. In operation, air is sucked through a compressor inlet of the housing to get accelerated and compressed by the compressor wheel and then exits the compressor via a volute of the compressor housing. Each compressor has its characterizing compressor map defining its operating range. This operating range is mainly bound by the surge line and the choke line in the compressor map.

[0004] To further improve the efficiency of the ICE, it is well known to enhance the compressor map, e.g. by preventing surging, i.e. by taking measures to move the surge line to the left. This can be done, for example, by compressor inlet adjustment mechanisms. Common adjustment mechanisms are configured, for instance, to increase the speed of the air flow, to modify the flow angle or to establish a flow path recirculation. When it comes to increasing the speed of the air flow, it is known to reduce an inlet diameter of the compressor inlet by means of orifice elements which are moved by an actuation ring. The actuation ring itself is usually coupled to and moved by a plurality of intermediate elements, such as a lever assembly, to, i.e. by an actuator. These measures and elements typically require space, may increase the weight, may lead to increased manufacturing costs and may increase the need for maintenance due to wear.

[0005] Accordingly, the objective of the present invention is to provide an improved compressor inlet adjustment mechanism.

Summary

[0006] The present invention relates to an adjustment mechanism as set out in claim 1. Furthermore, the present invention relates to a corresponding adjusting assembly, a compressor and a corresponding charging apparatus each including such an adjustment mechanism as set out in claims 5, 14 and 15, respectively. Other embodiments are described in the dependent claims.

[0007] The inventive adjustment mechanism for variably adjusting the cross-section of a compressor inlet comprises a plurality of rotatable orifice elements and a transmission ring. Each orifice element has a plate body, a coupling element and a bearing pin. The transmission ring is mechanically coupled to the plurality of orifice elements via the coupling elements. One of the orifice elements is configured as a drive orifice element. The bearing pin of the drive orifice element is configured as an elongated bearing pin. The elongated bearing pin is configured longer than the bearing pins of the other orifice elements. Furthermore, the elongated bearing pin is adapted to be coupled to an actuation system such that when the drive orifice element is moved by the actuation system, movement is transmitted from the drive orifice element via the transmission ring to the other orifice elements. The inventive configuration of the adjustment mechanism results in a different force flow in comparison to known adjustment mechanisms. The actuation force is led from an actuation system directly into the drive orifice element via rotation of the elongated bearing pin. Thereby the drive orifice element together with its coupling element can be pivoted. The coupling element of the drive orifice element in turn interacts with the transmission ring such that the transmission ring is rotated. Via the transmission ring force is transmitted from the drive orifice element to the other orifice elements thereby causing pivoting movement of the orifice elements to adjust the cross-section of a compressor inlet. The orifice elements are circumferentially distributed along the transmission ring. Optionally, the orifice elements may be configured and arranged such that they can contact respective adjacent orifice elements in a circumferential direction. Thereby, for instance the drive orifice element can push adjacent orifice elements during movement additionally to the force transmission through the transmission ring. The orifice elements being adjacent to the drive orifice element can in turn push respective adjacent orifice elements. Thereby a progression of direct force transmission from one orifice element to another orifice element can be accomplished. This auxiliary direct force transmission from the drive orifice element to its adjacent orifice elements (and further on) can improve the dynamics of the adjustment mechanism, particularly it can support the initial movement of the transmission ring. The inventive configuration of the drive orifice element can eliminate the need for a lever assembly or other intermediate parts as used in known systems. Consequently, this leads to less required parts, reduced space requirements, a better packaging and decreased manufacturing costs.

[0008] In one aspect of the adjustment mechanism, the bearing pin is arranged further radially outside on the respective orifice element than the coupling element. In particular, the bearing pin is arranged further radially outside on the plate body than the coupling element. Additionally or alternatively the coupling element is arranged in a radial middle portion of the respective orifice element. Additionally or alternatively the bearing pin is arranged in a radial outer portion of the respective orifice element. In particular, the bearing pin is arranged at a radial outer end of the respective orifice element. By arranging the bearing pin radially outside of the coupling element, the traveling distance of the respective coupling element relative to the transmission ring can be reduced. Thereby the potential wear of each coupling element and wear of the transmission ring can be reduced. Especially, an increasing distance between the coupling element and the respective bearing pin of one orifice element leads to a reduced relative movement between each coupling element and the transmission ring. Furthermore, by arranging the bearing pin radially outside the coupling element, i.e. farther away from the compressor axis in a radial outside direction, less rotation of the whole orifice element is required for moving the plate body between an opened and a closed position. This also results in less wear.

[0009] In another aspect, which is combinable with the previous aspect, the coupling element and the bearing pin may protrude directly from the plate body of the respective orifice element in an axial direction. In other words, the coupling element and the bearing pin are integrally formed with the plate body.

[0010] In another aspect, which is combinable with any one of the previous aspects, each orifice element may have an upstream surface and a downstream surface. The upstream surface points in a first axial direction to an upstream side. The downstream surface points in a second axial direction to a downstream side opposite the first axial direction.

[0011] In another aspect, which is combinable with the previous aspect, the coupling elements may extend from the upstream surface in the first axial direction. Alternatively, the coupling elements may extend from the downstream surface in the second axial direction.

[0012] Additionally or alternatively to the previous aspect, the transmission ring may be arranged axially adjacent the upstream surfaces or axially adjacent the downstream surfaces.

[0013] Additionally or alternatively to the previous aspect, the coupling elements and the transmission ring may be arranged on the same of one of the upstream side or the downstream side.

[0014] Additionally or alternatively to the previous aspect, the elongated bearing pin may always arranged on the upstream side. The elongated bearing pin may extend from the upstream surface in the first axial direction.

[0015] Additionally or alternatively to the previous aspect, the bearing pins of the other orifice elements may extend from the upstream surface in the first axial direction. Alternatively the bearing pins of the other orifice elements extend from the downstream surface in the second axial direction.

[0016] In another aspect, which is combinable with any one of the previous aspects, the transmission ring may have a plurality of circumferentially arranged recesses. Each coupling element may be operatively coupled to one respective recess. Additionally each recess may have a longitudinal shape extending in a substantially radial direction. Thereby, each coupling element can slide within the respective recess in a radial direction. Furthermore, movement between the transmission ring and the orifice elements can be transmitted in a circumferential direction.

[0017] In another aspect, which is combinable with any one of the previous aspects, the adjustment mechanism may further comprise a housing portion. Additionally, the housing portion may have a bore. Additionally, the elongated bearing pin may extend through the bore to be coupled to the actuation system outside the housing portion. Additionally, the housing portion may be an inlet port of a compressor defining the compressor inlet.

[0018] The present invention further relates to an adjustment assembly for variably adjusting the cross-section of a compressor inlet. The adjustment assembly comprises an adjustment mechanism of any one of the previous aspects. Furthermore, the adjustment assembly comprises an actuation system. The actuation system is configured to actuate the drive orifice element. That means the drive orifice element is operatively coupled to the actuation system. The actuation system may comprise a drive unit. The drive unit is configured as a rotatory drive unit. Additionally, a first geared structure may be arranged in a first end portion of the elongated bearing pin. Additionally, the adjustment assembly may further comprise a first geared element. The first geared element may be arranged at the first end portion and may comprise the first geared structure. The first geared element may be attached in a rotationally fixed manner to the first end portion. The first geared structure may be arranged on a radial surface of the elongated bearing pin or on a radial surface of the geared element, i.e. a surface pointing in a radial direction with respect to the elongated bearing pin. In embodiments comprising the first geared element, a length of the geared element in a radial direction with respect to the elongated bearing pin may be configured to place the actuation system closer or further away from the elongated bearing pin. In other words, by providing the first geared element a distance between the actuation system and the elongated bearing pin and/or the housing portion can be adjusted. This enables a flexible placement of the actuation system by adequately configuring the first geared element. Furthermore, the possibility is provided to use different actuation systems, for instance actuation systems of different sizes. In other words, the first geared structure can either be provided directly in the elongated bearing pin or in an additional element, i.e. the first geared element. If the first geared structure is directly formed on the elongated bearing pin, the first geared structure may optionally be arranged in a geared recess of the elongated bearing pin. The geared recess may be formed in an end face of the elongated bearing pin. Thereby the actuation system can directly be coupled to the elongated bearing pin in a very compact fashion. The actuation system can be arranged closer to the housing portion. Consequently, a more compact device can be provided.

[0019] In another aspect of the adjustment assembly, the first geared structure may extend at least along an arc length of a circular sector. Additionally, the circular sector may be defined by a central angle θ_1 between 5° to 360°, preferably between 10° to 60°and in particular between 15° and 45°. By adapting the central angle θ_1 smaller than 360° no full rotation is required. Furthermore, the manufacturing costs can be reduced as a smaller area needs to be provided in a geared configuration.

[0020] Additionally or alternatively to the previous aspect, the adjustment assembly may further comprise a second geared structure. The second geared structure may be formed complementary to the first geared structure and may be operatively coupled to the drive unit. Furthermore, the second geared structure may be engagingly coupled to the first geared structure in order to rotate the elongated bearing pin. In other words, the actuation system may comprise the second geared structure. Additionally, the adjustment assembly may further comprise a rotatable drive shaft. The rotatable drive shaft may be operatively coupled to the drive unit. That means the actuation system may comprise the rotatable drive shaft. Additionally, the second geared structure may directly be formed on the rotatable drive shaft. In particular, the second geared structure may directly be formed in a second shaft end portion of the rotatable drive shaft. If the second geared structure is directly formed on the rotatable drive shaft, the second geared structure may optionally be arranged in a geared recess of the rotatable drive shaft. The geared recess may be formed in a shaft end face of the rotatable drive shaft. Thereby the actuation system can directly be coupled to the elongated bearing pin in a very compact fashion. The actuation system can be arranged closer to the housing portion. Consequently, a more compact device can be provided. Alternatively to being directly formed on the rotatable drive shaft, the adjustment assembly, i.e. the actuation system may further comprise a second geared element which comprises the second geared structure. The second geared element may operatively be coupled to the drive unit. The second geared element may be arranged on the rotatable drive shaft. In particular, the second geared element may be arranged in a second shaft end portion of the rotatable drive shaft. Thereby the second geared element can be operatively coupled to the drive unit via the rotatable drive shaft. Additionally, the second geared element may be attached to the rotatable drive shaft in a rotationally fixed manner.

[0021] In another aspect of the adjustment assembly which is combinable with the previous aspect, the second geared structure may extend at least along an arc length of a circular sector. Additionally, the circular sector may be defined by a central angle θ_2 between 5° to 360°, preferably between 10° to 60°and in particular between 15° and 45°.

[0022] Alternatively to the previous aspect, the second geared element is configured as a gear rack.

[0023] The present invention further relates to a compressor of a charging apparatus. The compressor comprises a compressor housing, an impeller and an adjustment assembly of any one of the previous aspects. The compressor housing defines a compressor inlet and a compressor outlet. The impeller is rotatably mounted in the compressor housing between the compressor inlet and the compressor outlet. Additionally, if the adjustment mechanism comprises a housing portion, the housing portion is part of the compressor housing. Furthermore, the housing portion forms the compressor inlet. In other words, the housing portion serves as inlet port of the compressor. Thereby, the housing portion may be attached to the compressor housing. The housing portion may be arranged upstream of the impeller.

[0024] The present invention further relates charging apparatus. The charging apparatus comprises a compressor drive unit and a compressor of any one of the previous aspects. The compressor is rotationally coupled to the compressor drive unit via a shaft.

[0025] In one aspect of the charging apparatus, the compressor drive unit may comprise a turbine. Additionally or alternatively the compressor drive unit may comprise an electric motor.

Description of the Drawings

[0026]

FIG. 1	shows a sectional view of charging apparatus without the inventive adjustment mechanism;
FIGS. 2A - 2B	show the inventive adjustment mechanism in isometric views from the top (upstream side) and bottom (downstream side);
FIGS. 3A - 3B	show the adjustment mechanism of FIG. 2A in an opened and in a closed state;
FIG. 4A	shows the adjustment mechanism including a housing portion, i.e. the adjustment assembly including an actuation system in an exploded view;
FIG. 4B	shows the adjustment mechanism and the adjustment assembly of FIG. 4A in an assembled state, the actuation system of the adjustment assembly not being coupled to the elongated bearing pin;
FIGS. 5A - 5B	show the adjustment assembly in iso-

metric sectional views from the top (upstream side) and bottom (downstream side);

FIG. 6 shows the compressor including the adjustment assembly of FIG. 4A in an exploded view without an impeller;

FIG. 7 shows a sectional side view of the compressor of FIG. 6, but in assembled state;

FIG. 8 shows an isometric view of the compressor of FIG. 7, but with a first geared element and a second geared element;

FIGS. 9A-9C show different configurations of the first geared structure;

FIGS. 10A-10D show different configurations of the second geared structure.

Detailed Description

[0027] In the context of this invention, the expressions axially, axial or axial direction is meant to be a direction parallel of or along an axis, i.e. rotational axis, of the transmission ring. When the adjustment mechanism is mounted in a compressor housing, the axial direction also substantially coincides with an axis of the compressor, i.e. with a rotation axis of the compressor wheel. Thus, with reference to the figures, see, especially **Fig. 2A** and **FIG. 6,** an axial dimension is described with reference sign 22, a radial dimension extending "radially" away from the axial dimension 22 is described with reference sign 24. Furthermore, a circumferential dimension around the axial dimension 22 is described with reference sign 26. If an axial, radial or circumferential directions/dimension is to be understood in another way than just described it is explicitly indicated (e.g. radially from an axis of the elongated bearing pin).

[0028] **Fig. 1** schematically illustrates the inventive charging apparatus 400 having a compressor 300 and a compressor drive unit 410. The compressor 300 is rotationally coupled to the compressor drive unit 410 via a shaft 420. In the exemplary embodiment of **FIG. 1** the compressor drive unit 410 is configured as an exhaust gas turbine. However, in alternative embodiments the compressor drive unit 410 can be configured as an electric motor or may be configured as a combination of an exhaust gas turbine and an electric motor. The compressor 300 comprises a compressor housing 310 and an impeller 320. The compressor housing 310 defines a compressor inlet 312 and a compressor outlet 314. The impeller 320 is rotatably mounted in the compressor housing 310 between the compressor inlet 312 and the compressor outlet 314. Furthermore, the compressor 300 comprises an adjustment assembly 30. The adjustment assembly 30 comprises an adjustment mechanism 10 and an actuation system 230.

[0029] With reference to **FIGS. 2A and 2B** the adjustment mechanism 10 for variably adjusting the cross-section 312a of a compressor inlet 312 will be explained in further detail. The adjustment mechanism 10 comprises a plurality of rotatable orifice elements 100, 100' and a transmission ring 210. Each orifice element 100, 100' has a plate body 130, a coupling element 110 and a bearing pin 120, 120'. The transmission ring 210 is mechanically coupled to the plurality of orifice elements 100, 100' via the coupling elements 110 (see in particular **FIG. 2B**). One of the orifice elements 100, 100' is configured as a drive orifice element 100'. The bearing pin 120' of the drive orifice element 100' is configured as an elongated bearing pin 120'. The elongated bearing pin 120' is configured longer than the bearing pins 120 of the other orifice elements 100. Furthermore, the elongated bearing pin 120' is adapted to be coupled to an actuation system 230 (not depicted here, see adjustment assembly 30, e.g., **FIG. 4B or 5A**) such that when the drive orifice element 100' is moved by the actuation system 230, movement is transmitted from the drive orifice element 100' via the transmission ring 210 to the other orifice elements 100. Thus, for instance the length of the elongated bearing pin 120' is adapted long enough to be coupled to the actuation system 230. Other adaptations of the elongated bearing pin 120' will be described later with reference to the adjustment assembly 30. The inventive configuration of the adjustment mechanism 10 results in a different force flow in comparison to known adjustment mechanisms. The actuation force is led from an actuation system 230 directly into the drive orifice element 100' via rotation of the elongated bearing pin 120'. Thereby the drive orifice element 100' together with its coupling element 110 can be pivoted. In detail the drive orifice element 100' can be pivoted around the axis of the elongated bearing pin 120'. The coupling element 110 of the drive orifice element 100' in turn interacts with the transmission ring 210 such that the transmission ring 210 is rotated. Via the transmission ring 210 force is transmitted from the drive orifice element 100' to the other orifice elements 100 thereby causing pivoting movement of the orifice elements 100 (around the respective axis of their respective bearing pin 120) to adjust the cross-section 312a of the compressor inlet 312. Thus, the adjustment mechanism 10 can be moved between an opened position or opened state in which the cross-section 312a of the compressor inlet 312 is maximal and a closed position or closed state in which the cross-section 312a of the compressor inlet 312 is reduced. This is illustrated in **FIGS. 3A and 3B. FIG. 3A** shows the opened state of the adjustment mechanism 10 in which the orifice elements 100, 100' are pivoted radially outside, i.e. radially away from the center (see arrow indicating the axial direction 22) of the transmission ring 210. In contrast hereto, **FIG. 3A** shows the closed state of the adjustment mechanism 10 in which the orifice elements 100, 100' are pivoted radially inside, i.e. radially towards from the center of the transmission ring 210. In this closed state, the orifice elements 100, 100', i.e. their respective plate bodies 130 can block a radial outer portion of the cross-section 312a of the compressor inlet 312 and thereby reduce the cross-section 312a. To better understand the latter explanations, reference is also given to **FIG. 7** which more clearly depicts this functionality as it shows the adjustment mechanism 10 mounted in a compressor housing 310. Here it becomes evident, that when the adjustment mechanism 10 is depicted in a closed state, the orifice elements 100, 100' block a portion of the compressor inlet 312 and thereby reduce the cross-section 312a of the compressor inlet 312.

[0030] Again with reference to **FIGS. 3A and 3B,** it can be seen that the orifice elements 100, 100' are distributed along the transmission ring 210 in a circumferential direction 26. The orifice elements 100, 100' are configured and arranged such that they contact respective adjacent orifice elements 100, 100' in a circumferential direction 26. The physical contact enables the possibility that the drive orifice element 100' can push adjacent orifice elements 100 during movement. This "direct push movement" can be exerted on adjacent orifice elements 100 additionally to the force transmission through the transmission ring 210. Those orifice elements 100 being adjacent to the drive orifice element 100' can in turn push respective adjacent orifice elements 100. Thereby a progression of direct force transmission from one orifice element 100, 100' to another orifice element 100, 100' can be accomplished. This auxiliary direct force transmission from the drive orifice element 100' to its adjacent orifice elements 100 (and further on) can improve the dynamics of the adjustment mechanism 10. In particular, it can support the initial movement of the transmission ring 210. The inventive configuration of the drive orifice element 100' which is directly coupleable with the actuation system 230 can eliminate the need for a lever assembly or other intermediate parts as used in known systems. Consequently, this leads to less required parts, reduced space requirements, a better packaging and decreased manufacturing costs.

[0031] With further reference to **FIGS. 2B and 3B,** each orifice element 100, 100', more specifically each plate body 130, comprises a radial middle portion 136, a radial outer portion 138 and a radial outer end 138a. The radial middle portion 136 is a portion of the plate body 130 which is located in a radial middle area of the plate body 130 when the adjustment mechanism 10 is in the closed state. The radial outer portion 138 is a portion of the plate body 130 which is located in a radial outer area of the plate body 130 when the adjustment mechanism 10 is in the closed state. The radial outer end 138a is a portion of the plate body 130 which is located in a radial outer end of the plate body 130 when the adjustment mechanism 10 is in the closed state. When the adjustment mechanism 10 is moved to the opened state, the respective portions 138, 138 and the end 138a correspondingly move too but remain fixed with respect to the respective plate body 130. Each respective bearing pin 120, 120' is arranged at the radial outer end 138a of the respective orifice element 100, 100' (see, e.g., **FIG. 3B**). Each respective coupling element 110 is arranged in the radial middle portion 136 of the respective orifice element 100, 100' (see, e.g., **FIG. 2B**). Alternatively, the bearing pin 120, 120' can also be arranged in a radial outer portion 138 of the respective orifice element 100, 100 and need not be arranged exactly at the radial outer end 138a. However, in all embodiments the bearing pin 120, 120' is preferentially arranged further radially outside on the respective orifice element 100, 100' than the coupling element 110. By arranging the bearing pin 120, 120' radially outside of the coupling element 110, the traveling distance of the respective coupling element 110 relative to the transmission ring 210 can be reduced. Thereby the potential wear of each coupling element 110 and potential wear of the transmission ring 210 can be reduced. Especially, an increasing distance between the coupling element 110 and the respective bearing pin 120, 120' of a respective orifice element 100, 100' leads to a reduced relative movement between each coupling element 110 and the transmission ring 210. Furthermore, by arranging the bearing pin 120, 120' radially outside the coupling element 110, i.e. farther away from the compressor axis in a radial outside direction 24, less rotation of the whole orifice element 100, 100' is required for moving the plate body 130 between an opened closed and a closed position. This also results in less wear, in particular less wear of the bearing pin 120, 120'.

[0032] As depicted in **FIGS. 2A and 2B** each orifice element 100, 100' has an upstream surface 132 and a downstream surface 134. More specifically, each plate body 130 of the respective orifice element 100, 100' has an upstream surface 132 and a downstream surface 134. The upstream surface 132 points in a first axial direction 22a to an upstream side 132a of the adjustment mechanism 10. The downstream surface 134 points in a second axial direction 22b to a downstream side 134a of the adjustment mechanism 10 opposite the first axial direction 22a. Thus, the first axial direction 22a extends opposite the second axial direction 22b. In general, the upstream side 132a and the downstream side 134a are defined by means of the flow direction of fluids through the compressor in the assembled state of the adjustment mechanism in a compressor 300 during operation. Therefore, see additionally FIG. 7 which shows the adjustment mechanism 10 assembled in a compressor housing 310 clarifying the upstream side 132a and downstream side 134a also with respect to the adjustment mechanism 10.

[0033] The coupling element 110 and the bearing pin 120, 120' directly protrude from the plate body 130 of the respective orifice element 100, 100' generally in an axial direction 22. In the illustrated embodiments the bearing elements 120, 120' extend in the first axial direction 22a from the plate body 130 of the respective orifice element 100, 100'. In other words, the coupling element 110 and the bearing pin 120, 120' are integrally formed with the respective plate body 130 of one orifice element 100, 100'. The coupling elements 110 extend in the second axial direction 22b from the plate body 130 of the respective orifice element 100, 100'. The transmission ring 210 is arranged axially adjacent the downstream surfaces 134 of the orifice elements 100, 100'. In other words, the transmission ring 210 is arranged axially adjacent the downstream surfaces 134 of the plate bodies 130. The transmission ring 210 has a plurality of circumferentially arranged recesses 212 (see **FIGS. 2B and 3B**). Each coupling element 110 is operatively coupled to one respective recess 212. Each recess 212 has a longitudinal shape extending in a substantially radial direction 22. Thereby, each coupling element 110 can slide within the respective recess 212 in a radial direction 22. Thus, the coupling elements 110 engage with a respective recess 212. That means the transmission ring 210 needs to be arranged on the same side of the plate body 130 as the coupling elements 110. Thereby movement can be transmitted between the transmission ring 210 and the orifice elements 100, 100' in a circumferential direction 26. Alternatively, to extending from the downstream surface 134 in the second axial direction 22b, the coupling elements 110 may extend from the upstream surface 132 in the first axial direction 22a (not depicted). In this case the transmission ring 210 may also be arranged axially adjacent the upstream surface 132 of the plate bodies 130. Preferably, the transmission ring 210 and the coupling elements 110 are arranged axially adjacent the downstream side 134 as this may lead to a good stability of the adjustment mechanism 10 during movement. Arranging the transmission ring 210 and the coupling elements 110 on the upstream side 132a may lead to a more compact device. The elongated bearing pin 120' must always be arranged on the upstream side 132a. In other words, the elongated bearing pin 120' must always extend from the upstream surface 132 in the first axial direction 22a. Thereby an easy accessibility to the actuation system 230 can be achieved. However, in alternative embodiments, some or all of the bearing pins 120 of the other orifice elements 100 can extend from the downstream surface 134 in the second axial direction 22b. In embodiments where some or all of the bearing pins 120, 120' are arranged on the same side of the plate body 130 as the transmission ring 210, the respective bearing pins need to be arranged radially outside the transmission ring 210. Bearing pins 120, 120' which are arranged on an opposite site of the plate body 130 than the transmission ring 210 do not necessarily be arranged radially outside the transmission ring 210.

[0034] As depicted in **FIGS. 4A and 4B,** the adjustment mechanism 10 further comprises a housing portion 220 with an inlet portion 226 and a flange portion 228. The housing portion 220 may serve as an inlet port for the compressor 300 and defines the compressor inlet 312. The housing portion 220 comprises a bore 222 which is configured to receive the elongated bearing pin 120'. The bore 222 extends through the flange portion 228 in the axial direction 22. Described in other words, the elongated bearing pin 120' extends through the bore 222 to be coupled to the actuation system 230 outside the housing portion 220. Optionally, a bushing (not depicted) may be arranged in the bore 222 and may rotatably support the elongated bearing pin 120'. **FIGS. 5B and 7** show that the housing portion 220 further comprises a plurality of circumferentially distributed bearing bores 224. The bearing bores 224 receive the bearing pins 120. Alternatively, if the bearing pins 120 are oriented in the opposite direction, i.e. if the bearing pins 120 extend from the body plates 130 in the second axial direction 22b, no bearing bores 224 may be provided in the housing portion 220. Instead, respective bearing bores 224 may be directly provided in the compressor housing 310. Alternatively, an additional bearing ring (not depicted) with a plurality of circumferentially distributed bearing bores 224 may be provided between the compressor housing 310 and the orifice elements 100, 100' or between the housing portion 220 and the orifice elements 100, 100' to support the bearing pins 120 of the orifice elements 100.

[0035] The present invention further relates to an adjustment assembly 30 for variably adjusting the cross-section 312a of a compressor inlet 312 (see **FIG. 4A**). The adjustment assembly 30 comprises the adjustment mechanism 10 with the housing portion 220. Additionally, the adjustment assembly 30 comprises an actuation system 230, which is schematically depicted in **FIGS. 4A to 5B.** The actuation system 230 is configured to actuate the drive orifice element 100'. That means the drive orifice element 100' is operatively coupled to the actuation system 230. The actuation system 230 comprises a drive unit 234 which is also merely schematically depicted. The drive unit 234 is configured as a rotatory drive unit. That means it generates a rotatory drive movement. This can help to further reduce the space requirements of the adjustment assembly 30. In some alternative embodiments, the drive unit 234 may be configured as a translational drive unit, i.e. generating a translational drive movement. This can be the case, for instance where the actuation system 230 comprises a gear rack which will be explained further below. For illustrative purposes, the actuation system 230 is depicted distanced from and not coupled to the drive orifice element 100' in **FIGS. 4A and 4B.** Thereby the function of the drive orifice element 100' becomes more clear. Especially, in **FIG. 4B** it can be seen that the elongated bearing pin 120'extends through the housing portion 220. However, it is to be understood that in the assembled state, the actuation system 230 is coupled, i.e. physically coupled, to the drive orifice element 100' (see **FIGS. 5A and 5B**). Here in **FIGS. 5A and 5B,** the actuation system 230 is directly coupled to the elongated bearing pin 120'. Therefore, the actuation system 230 is arranged on the elongated bearing pin 120'. Described in other words, the elongated bearing pin 120' extends into the actuation system 230. In this exemplary embodiment, the actuation system 230 is arranged directly at housing portion 220. This configuration results in an extremely compact assembly. For illustrative purposes, merely the flange portion 228 of the housing portion 220 is depicted in these figures, although the housing portion 220 also comprises the inlet portion 226 as explained further above. With further reference to **FIGS. 5A and 5B,** the adjustment assembly can additionally comprise a sealing 250 which is arranged between the housing portion 220 and the elongated bearing pin 120'. This sealing 250 can, for instance, be configured as a sealing ring. In the embodiment of **FIGS. 5A and 5B,** the actuation system 230 is mounted to the housing portion 220. The sealing 250 is arranged between the actuation system 230 and the housing portion 220. In alternative embodiments, the actuation system 230 need not be mounted directly at the housing portion 220. In particular, in such cases the sealing 250 may be arranged between the housing portion 220 and the elongated bearing pin 120' as described above. For instance, the sealing 250 can be arranged in or at the bore 222.

[0036] With reference to **FIGS. 9A to 9C,** the elongated bearing pin 120' comprises a first geared structure 142. The first geared structure 142 can either be provided directly in the elongated bearing pin 120' (see **FIGS. 9A and 9B**) or in an additional element, i.e. a first geared element 140 (see **FIG. 9C**).

[0037] When the first geared structure 142 is provided directly in the elongated bearing pin 120', it is arranged in a first end portion 122' of the elongated bearing pin 120'. The first geared structure 142 may be configured as an external toothing (see **FIG. 9A**) or an internal toothing (see **FIG. 9B**). The first geared structure 142 is arranged on a radial surface of the elongated bearing pin 120'. That means the first geared structure 142 is arranged on a surface of the elongated bearing pin 120' pointing in radial direction with respect to the rotation axis of the elongated bearing pin 120'. When the first geared structure 142 is configured as an external toothing, the first geared structure 142 is arranged on a radial outer surface of the elongated bearing pin 120'. In other words, the first geared structure 142 is arranged on a surface of the elongated bearing pin 120' pointing in radial outward direction of the rotation axis of the elongated bearing pin 120'. When the first geared structure 142 is configured as an internal toothing, the first geared structure 142 is arranged on a radial inner surface of the elongated bearing pin 120'. In other words, the first geared structure 142 is arranged on a surface of the elongated bearing pin 120' pointing in radial inward direction of the rotation axis of the elongated bearing pin 120'. Therefore, the elongated bearing pin 120' may comprise a geared recess 146. The geared recess 146 is formed in an end face 122a' of the elongated bearing pin 120'. The first geared structure 142 is arranged in the geared recess 146. By providing the first geared structure 142 directly in the elongated bearing pin 120', the actuation system 230 can directly be coupled to the elongated bearing pin 120' in a very compact fashion. The actuation system 230 can be arranged closer to the housing portion 220 (see, e.g., **FIGS. 5A and 5B**). Consequently, a more compact device can be provided.

[0038] **FIG. 9C** shows the adjustment assembly 30 comprising the first geared element 140. The first geared element 140 is arranged at the first end portion 122' and comprises the first geared structure 142. The first geared element 140 is attached in a rotationally fixed manner to the elongated bearing pin 120'. Preferably, the first geared element 140 is attached in a rotationally fixed manner to the first end portion 122'. The first geared structure 142 is arranged on a radial surface of the first geared element 140, i.e. a surface pointing in a radial direction with respect to the rotation axis of the elongated bearing pin 120'. A length of the first geared element 140 in a radial direction with respect to the rotation axis of the elongated bearing pin 120' may be configured to place the actuation system 230 closer or further away from the elongated bearing pin 120'. In other words, by providing the first geared element 140 a distance between the actuation system 230 and the elongated bearing pin 120' and/or the housing portion 220 can be adjusted. This enables a flexible placement of the actuation system 230 by adequately configuring the first geared element 140. Furthermore, the possibility is provided to use different actuation systems 230, for instance actuation systems 230 of different sizes.

[0039] With reference to **FIGS. 9A and 9C,** the first geared structure 142 extends only along an arc length 144a of a circular sector 144. The circular sector 144 is defined by a central angle θ_1 which is preferably between 10° to 60°. Alternatively, the central angle θ_1 may lie somewhere between 5° to 360° and in particular between 15° and 45°. Thus, in some embodiments the first geared structure 142 may alternatively also extend along the full circumference of the elongated bearing pin 120' or the first geared element 140. The first geared element 140 may be substantially shaped in a circular sector 144 or may substantially comprise only the circular sector 144 (see **FIG. 9C**). Alternatively, the first geared element 140 may be shaped circular (not depicted). By adapting the central angle θ_1 smaller than 360° no full rotation is required. Furthermore, the manufacturing costs can be reduced as a smaller area needs to be provided in a geared configuration.

[0040] With reference to **FIGS. 10A to 10D,** the adjustment assembly 30 comprises a second geared structure 242. More specifically, the actuation system 230 comprises the second geared structure 242. The second geared structure 242 is engagingly coupled to the first geared structure 142 in order to rotate the elongated bearing pin 120'. To achieve this, the second geared structure 242 is formed complementary to the first geared structure 142. Furthermore, the second geared structure 242 is operatively coupled to the drive unit 234. As depicted in **FIGS. 10A to 10 C,** the adjustment assembly 30 further comprises a rotatable drive shaft 232. More specifically, the actuation system 230 comprises the rotatably drive shaft 232. The rotatable drive shaft 232 is operatively coupled to the drive unit 234. The second geared structure 242 may either be provided directly in the rotatable drive shaft 232 (see **FIG. 10A**) or in an additional element, i.e. a second geared element 240 (see **FIGS. 10B and 10C**). The rotatable drive shaft 232 has a first shaft end portion 233 and a second shaft end portion 235. The first shaft end portion 233 is coupled to the drive unit 230. The second shaft end portion 235 is coupled to the elongated bearing pin 120'. More specifically, if the second geared element 240 is provided, the second shaft end portion 235 is coupled to the elongated bearing pin 120' via the second geared element 240.

[0041] When the second geared structure 242 is provided directly in the rotatable drive shaft 232, it is arranged in the second shaft end portion 235 of the rotatable drive shaft 232. That means, the second geared structure 242 is directly formed on the rotatable drive shaft 232 (see **FIG. 10A**). In the example of **FIG. 10A,** the second geared structure 242 is configured as an internal toothing. Alternatively, the second geared structure 242 may be configured as an external toothing (only depicted together with an additional element in **FIG. 10C,** but analogously to **FIG. 9A**). The second geared structure 242 is arranged on a radial surface of the rotatable drive shaft 232. That means the second geared structure 242 is arranged on a surface of the rotatable drive shaft 232 pointing in radial direction with respect to the rotation axis of the rotatable drive shaft 232. When the second geared structure 242 is configured as an external toothing, the second geared structure 242 is arranged on a radial outer surface of the rotatable drive shaft 232. In other words, the second geared structure 242 is arranged on a surface of the rotatable drive shaft 232 pointing in radial outward direction of the rotation axis of the rotatable drive shaft 232. When the second geared structure 242 is configured as an internal toothing, the second geared structure 242 is arranged on a radial inner surface of the rotatable drive shaft 232. In other words, the second geared structure 242 is arranged on a surface of the rotatable drive shaft 232 pointing in radial inward direction of the rotation axis of the rotatable drive shaft 232. Therefore, the rotatable drive shaft 232 comprises a geared recess 246. The geared recess 246 is formed in a shaft end face 235a of the rotatable drive shaft 232. The second geared structure 242 is arranged in the geared recess 246. By providing the second geared structure 242 directly in the rotatable drive shaft 232, the actuation system 230 can directly be coupled to the elongated bearing pin 120' in a very compact fashion. The actuation system 230 can be arranged closer to the housing portion 220 (see, e.g., **FIGS. 5A and 5B**). Consequently, a more compact device can be provided.

[0042] Also when having a second geared element 240, the second geared structure 242 may be configured as an external toothing (see **FIG. 10C**) or an internal toothing (see **FIG. 10B**). The second geared element 240 comprises the second geared structure 242. The second geared element 240 is arranged in the second shaft end portion 235 of the rotatable drive shaft 232. The second geared element 240 is attached in a rotationally fixed manner to the rotatable drive shaft 232. Preferably, the second geared element 240 is attached in a rotationally fixed manner to the second shaft end portion 235. The second geared element 240 is operatively coupled to the drive unit 234. More specifically, the second geared element 240 is operatively coupled to the drive unit via the rotatable drive shaft 232. The second geared structure 242 is arranged on a radial surface of the second geared element 240, i.e. a surface pointing in a radial direction with respect to the rotation axis of the rotatable drive shaft 232. A length of the second geared element 240 in a radial direction with respect to the rotation axis of the rotatable drive shaft 232 may be configured to place the actuation system 230 closer or further away from the elongated bearing pin 120'. In other words, by providing the second geared element 240 a distance between the actuation system 230 and the elongated bearing pin 120' and/or the housing portion 220 can be adjusted. This enables a flexible placement of the actuation system 230 by adequately configuring the second geared element 240. Furthermore, the possibility is provided to use different actuation systems 230, for instance actuation systems 230 of different sizes.

[0043] In general, various combinations of the first geared structure 142 and/or the first geared element 140 and the second geared structure 242 and/or the second geared element 240 are possible. For instance, the first geared structure 142 according to the embodiment of **FIG. 9A** may be combined with the second geared structure 242 according to any of the embodiments depicted in **FIGS. 10A, 10B, 10C or 10D.** The embodiment of **FIG. 10D** thereby represents a variation wherein the second geared element 240 is configured as a gear rack. In this case, the actuation system 230 does not comprise a rotatable drive shaft 232. Instead, the gear rack is directly coupled with the drive unit 234 and the drive unit is configured as a translational drive unit 234.

[0044] Analogously to the first geared structure 142, the second geared structure may extend only along an arc length 244a of a circular sector 244 (see **FIG. 10C**). The circular sector 244 is defined by a central angle θ_2 which is preferably between 10° to 60°. Alternatively, the central angle θ_2 may lie somewhere between 5° to 360° and in particular between 15° and 45°. Thus, in some embodiments the second geared structure 242 may alternatively also extend along the full circumference of the rotatable drive shaft 232 (if the second geared structure 242 is directly provided on the rotatable drive shaft 232 and configured as an external toothing) or the second geared element 240. The second geared element 240 may be substantially shaped in a circular sector 244 or may substantially comprise only the circular sector 244 (see **FIG. 10C**). Alternatively, the second geared element 240 may be shaped circular (not depicted). By adapting the central angle θ_1 smaller than 360° no full rotation is required. Furthermore, the manufacturing costs can be reduced as a smaller area needs to be provided in a geared configuration.

[0045] With reference to **FIGS. 6, 7 and 8,** the compressor 300 is shown in more detail. As already stated further above, the compressor 300 comprises the adjustment assembly 30 including the adjustment mechanism 10 with the housing portion 220. Furthermore, the compressor 300 comprises the compressor housing 310. The adjustment assembly 30 is inserted into the compressor housing 310 (see **FIG. 8**). Thus, the housing portion 220 forms part of the compressor housing 310. More specifically, the housing portion 220 forms the compressor inlet 312. In other words, the housing portion 220 serves as inlet port of the compressor 300. The housing portion 220 is attached to the compressor housing 310 via its flange portion 228. Although the impeller 320 is not depicted **FIGS. 6, 7 and 8,** the housing portion 220 is arranged upstream of the impeller 320 (see, e.g., **FIG. 1**). **FIG. 7** shows in detail how the orifice elements 100, 100' and the transmission ring 210 is arranged in the compressor housing 310. It is clearly visible that the elongated bearing pin 120'extends through the housing portion 222 to be coupled with the actuation system 230, i.e. the drive unit 234 outside the compressor housing 310. Here in **FIG. 7,** the elongated bearing pin 120' is directly coupled to the actuation system 230. **FIG. 8** shows another exemplary configuration in which the elongated bearing pin 120' is coupled to the actuation system 230 via the first geared element 140 and the second geared element 240.

[0046] It should be understood that the present invention can also (alternatively) be defined in accordance with the following embodiments:

1. An adjustment mechanism (10) for variably adjusting the cross-section 312a of a compressor inlet (312) comprising:

    a plurality of rotatable orifice elements (100, 100') each having a plate body (130), a coupling element (110) and a bearing pin (120, 120'); and
    a transmission ring (210) mechanically coupled to the plurality of orifice elements (100) via the coupling elements (110);
    wherein
    one of the orifice elements (100, 100') is configured as a drive orifice element (100') whose bearing pin (120') is configured as an elongated bearing pin (120') being longer than the bearing pins (120) of the other orifice elements (100), wherein the elongated bearing pin (120') is adapted to be coupled with an actuation system (230),
    such that when the drive orifice element (100') is moved by the actuation system (230), movement is transmitted from the drive orifice element (100') via the transmission ring (210) to the other orifice elements (100).

2. The adjustment mechanism (10) of embodiment 1, wherein the bearing pin (120, 120') is arranged further radially outside on the respective orifice element (100, 100'), in particular on the plate body (130) than the coupling element (110).

3. The adjustment mechanism (10) of any one of the previous embodiments, wherein the coupling element (110) and the bearing pin (120, 120') protrude directly from the plate body (130) of the respective orifice element (100, 100') in an axial direction (22).

4. The adjustment mechanism (10) of any one of the previous embodiments, wherein the coupling element (110) is arranged in a radial middle portion (136) of the respective orifice element (100, 100') wherein the bearing pin (120, 120') is arranged in a radial outer portion (138), in particular at an radial outer end (138a) of the respective orifice element (100, 100').

5. The adjustment mechanism (10) of any one of the previous embodiments, wherein each orifice element (100, 100') has an upstream surface (132) and a downstream surface (134), wherein the upstream surface (132) points in a first axial direction (22a) to an upstream side (132a) and wherein the downstream surface (134) points in a second axial direction (22b) to a downstream side (134a) opposite the first axial direction (22a).

6. The adjustment mechanism (10) of embodiment 5, wherein the coupling elements (110) extend from the upstream surface (132) in the first axial direction (22a) or from the downstream surface (134) in the second axial direction (22b).

7. The adjustment mechanism (10) of any one of embodiments 5 or 6, wherein the transmission ring (210) is arranged axially adjacent the upstream surfaces (132) or axially adjacent the downstream surfaces (134).

8. The adjustment mechanism (10) of any one of embodiments 5 to 7, wherein the coupling elements (110) and the transmission ring (210) are arranged on the same of one of the upstream side (132a) or the downstream side (134a).

9. The adjustment mechanism (10) of any one of embodiments 5 to 8, wherein the elongated bearing pin (120') is always arranged on the upstream side (132a) and extends from the upstream surface (132) in the first axial direction (22a).

10. The adjustment mechanism (10) of any one of embodiments 5 to 9, wherein the bearing pins (120) of the other orifice elements (100) extend from the upstream surface (132) in the first axial direction (22a) or from the downstream surface (134) in the

second axial direction (22b).

11. The adjustment mechanism (10) of any one of the previous embodiments, wherein the transmission ring (210) has a plurality of circumferentially arranged recesses (212), wherein each coupling element (110) is operatively coupled with one respective recess (212).

12. The adjustment mechanism (10) of embodiment 5, each recess (212) has a longitudinal shape extending in a substantially radial direction (24) such that each coupling element (110) can slide within the respective recess (212) in a radial direction (22) and such that movement between the transmission ring (210) and the orifice elements (100, 100') can be transmitted in a circumferential direction (26).

13. The adjustment mechanism (10) of any one of the previous embodiments, further comprising a housing portion (220), optionally having a bore (222), and optionally, wherein the elongated bearing pin (120') extends through the bore (222) to be coupled with the actuation system (230) outside the housing portion (220).

14. The adjustment mechanism (10) of embodiment 13, wherein the housing portion (220) is an inlet port of a compressor (300) defining the compressor inlet (312).

15. An adjustment assembly (30) for variably adjusting the cross-section 312a of a compressor inlet (312), comprising:

an adjustment mechanism (10) of any one of the previous embodiments; and
an actuation system (230) to actuate the drive orifice element (100'), wherein the actuation system (230) is coupled to the elongated bearing pin (120') and, optionally, wherein the actuation system (230) comprises a drive unit (234), in particular, wherein the drive unit (234) is rotatory.

16. The adjustment assembly (30) of embodiment 15, wherein a first geared structure (142) is arranged in a first end portion (122') of the elongated bearing pin (120').

17. The adjustment assembly (30) of embodiment 16, further comprising a first geared element (140) arranged at the first end portion (122') and comprising the first geared structure (142).

18. The adjustment assembly (30) of embodiment 16, wherein the first geared structure (142) is directly formed on the elongated bearing pin (120'), and optionally, wherein a geared recess (146) is formed in an end face (122a') of the elongated bearing pin (120') and, wherein the geared recess (146) comprises the first geared structure (142).

19. The adjustment assembly (30) of any one of embodiments 16 to 18, wherein the first geared structure (142) extends at least along an arc length (144a) of a circular sector (144), and optionally, wherein the circular sector (144) is defined by a central angle θ_1 between 5° to 360°, preferably between 10° to 60°and in particular between 15° and 45°.

20. The adjustment assembly (30) of any of embodiments 16 to 19, further comprising a second geared structure (242) which is formed complementary to the first geared structure (142) and which is operatively coupled with the drive unit (234), wherein the second geared structure (242) is engagingly coupled with the first geared structure (142) in order to rotate the elongated bearing pin (120').

21. The adjustment assembly (30) of embodiment 20, further comprising a rotatable drive shaft (232) being operatively coupled with the drive unit (234).

22. The adjustment assembly (30) of embodiment 21, wherein the second geared structure (242) is directly formed on the rotatable drive shaft (232), in particular in a second shaft end portion (235) of the rotatable drive shaft (232), and optionally, wherein a geared recess (246) is formed in a shaft end face (235a) of the rotatable drive shaft (232) and, wherein the geared recess (246) comprises the second geared structure (242).

23. The adjustment assembly (30) of any one of embodiments 20 or 21, further comprising a second geared element (240) operatively coupled with the drive unit (234) and comprising the second geared structure (242).

24. The adjustment assembly (30) of embodiment 23, if dependent on embodiment 21, wherein second geared element (240) is arranged on the rotatable drive shaft (232), in particular in a second shaft end portion (235) of the rotatable drive shaft (232) in order to be operatively coupled with the drive unit (234) via the rotatable drive shaft (232).

25. The adjustment assembly (30) of any one of embodiments 20 to 24, wherein the second geared structure (242) extends at least along an arc length (244a) of a circular sector (244), and optionally, wherein the circular sector (244) is defined by a central angle θ_2 between 5° to 360°, preferably between 10° to 60°and in particular between 15° and 45°.

26. The adjustment assembly (30) of any one of embodiments 23 or 24, wherein second geared element (240) is configured as a gear rack.

27. The adjustment assembly (30) of any one of embodiments 15 or 16, 18 to 22 wherein the actuation system (230) is directly coupled with the elongated bearing pin (120') of the drive orifice element (100').

28. A compressor (300) of a charging apparatus (400), the compressor comprising:

a compressor housing (310) having a compressor inlet (312) and a compressor outlet (314);
an impeller (320) rotatably mounted in the compressor housing (310) between the compressor inlet (312) and the compressor outlet (314); and
an adjustment assembly (30) of any one of the previous embodiments.

29. The compressor (300) of embodiment 28, if dependent on embodiment 13, wherein the compressor housing (310) comprises the housing portion (220), and wherein the housing portion (220) forms the compressor inlet (312).

30. A charging apparatus (400) comprising:

a compressor drive unit (410); and
a compressor (300) of any one of the previous embodiments which is rotationally coupled to the compressor drive unit (410) via a shaft (420).

31. The charging apparatus (400) of embodiment 30, wherein the compressor drive unit (410) comprises a turbine and/or an electric motor.

Claims

1. An adjustment mechanism (10) for variably adjusting the cross-section (312a) of a compressor inlet (312) comprising:

a plurality of rotatable orifice elements (100, 100') each having a plate body (130), a coupling element (110) and a bearing pin (120, 120'); and
a transmission ring (210) mechanically coupled to the plurality of orifice elements (100) via the coupling elements (110);
wherein
one of the orifice elements (100, 100') is configured as a drive orifice element (100') whose bearing pin (120') is configured as an elongated bearing pin (120') being longer than the bearing pins (120) of the other orifice elements (100), wherein the elongated bearing pin (120') is adapted to be coupled with an actuation system (230),
such that when the drive orifice element (100') is moved by the actuation system (230), movement is transmitted from the drive orifice element (100') via the transmission ring (210) to the other orifice elements (100).

2. The adjustment mechanism (10) of claim 1, wherein the coupling element (110) is arranged in a radial middle portion (136) of the respective orifice element (100, 100') wherein the bearing pin (120, 120') is arranged in a radial outer portion (138), in particular at an radial outer end (138a) of the respective orifice element (100, 100').

3. The adjustment mechanism (10) of any one of the previous claims, wherein each orifice element (100, 100') has an upstream surface (132) and a downstream surface (134), wherein the upstream surface (132) points in a first axial direction (22a) to an upstream side (132a) and wherein the downstream surface (134) points in a second axial direction (22b) to a downstream side (134a) opposite the first axial direction (22a), and optionally, wherein the elongated bearing pin (120') is always arranged on the upstream side (132a) and extends from the upstream surface (132) in the first axial direction (22a).

4. The adjustment mechanism (10) of any one of the previous claims, further comprising a housing portion (220) having a bore (222), wherein the elongated bearing pin (120') extends through the bore (222) to be coupled with the actuation system (230) outside the housing portion (220), and optionally, wherein the housing portion (220) is an inlet port of a compressor (300) defining the compressor inlet (312).

5. An adjustment assembly (30) for variably adjusting the cross-section 312a of a compressor inlet (312), comprising:

an adjustment mechanism (10) of any one of the previous claims; and
an actuation system (230) to actuate the drive orifice element (100'), wherein the actuation system (230) is coupled to the elongated bearing pin (120') and, optionally, wherein the actuation system (230) comprises a drive unit (234), in particular, wherein the drive unit (234) is rotatory.

6. The adjustment assembly (30) of claim 5, wherein a first geared structure (142) is arranged in a first end portion (122') of the elongated bearing pin (120').

7. The adjustment assembly (30) of claim 6, further comprising a first geared element (140) arranged at the first end portion (122') and comprising the first geared structure (142).

8. The adjustment assembly (30) of claim 6, wherein the first geared structure (142) is directly formed on the elongated bearing pin (120'), and optionally, wherein a geared recess (146) is formed in an end face (122a') of the elongated bearing pin (120') and, wherein the geared recess (146) comprises the first geared structure (142).

9. The adjustment assembly (30) of any one of claims 6 to 8, wherein the first geared structure (142) extends at least along an arc length (144a) of a circular sector (144), and optionally, wherein the circular sector (144) is defined by a central angle θ_1 between 5° to 360°, preferably between 10° to 60°and in particular between 15° and 45°.

10. The adjustment assembly (30) of any of claims 6 to 9, further comprising a second geared structure (242) which is formed complementary to the first geared structure (142) and which is operatively coupled with the drive unit (234), wherein the second geared structure (242) is engagingly coupled with the first geared structure (142) in order to rotate the elongated bearing pin (120'), and optionally further comprising a rotatable drive shaft (232) being operatively coupled with the drive unit (234).

11. The adjustment assembly (30) of claim 10, wherein the second geared structure (242) is directly formed on the rotatable drive shaft (232), in particular in a second shaft end portion (235) of the rotatable drive shaft (232), and optionally, wherein a geared recess (246) is formed in a shaft end face (235a) of the rotatable drive shaft (232) and, wherein the geared recess (246) comprises the second geared structure (242).

12. The adjustment assembly (30) of claim 10, further comprising a second geared element (240) operatively coupled with the drive unit (234) and comprising the second geared structure (242).

13. The adjustment assembly (30) of any one of claims 5 or 6, 8 to 11 wherein the actuation system (230) is directly coupled with the elongated bearing pin (120') of the drive orifice element (100').

14. A compressor (300) of a charging apparatus (400), the compressor comprising:

a compressor housing (310) having a compressor inlet (312) and a compressor outlet (314);
an impeller (320) rotatably mounted in the compressor housing (310) between the compressor inlet (312) and the compressor outlet (314); and
an adjustment assembly (30) of any one of the previous claims.

15. A charging apparatus (400) comprising:

a compressor drive unit (410); and
a compressor (300) of any one of the previous claims which is rotationally coupled to the compressor drive unit (410) via a shaft (420).

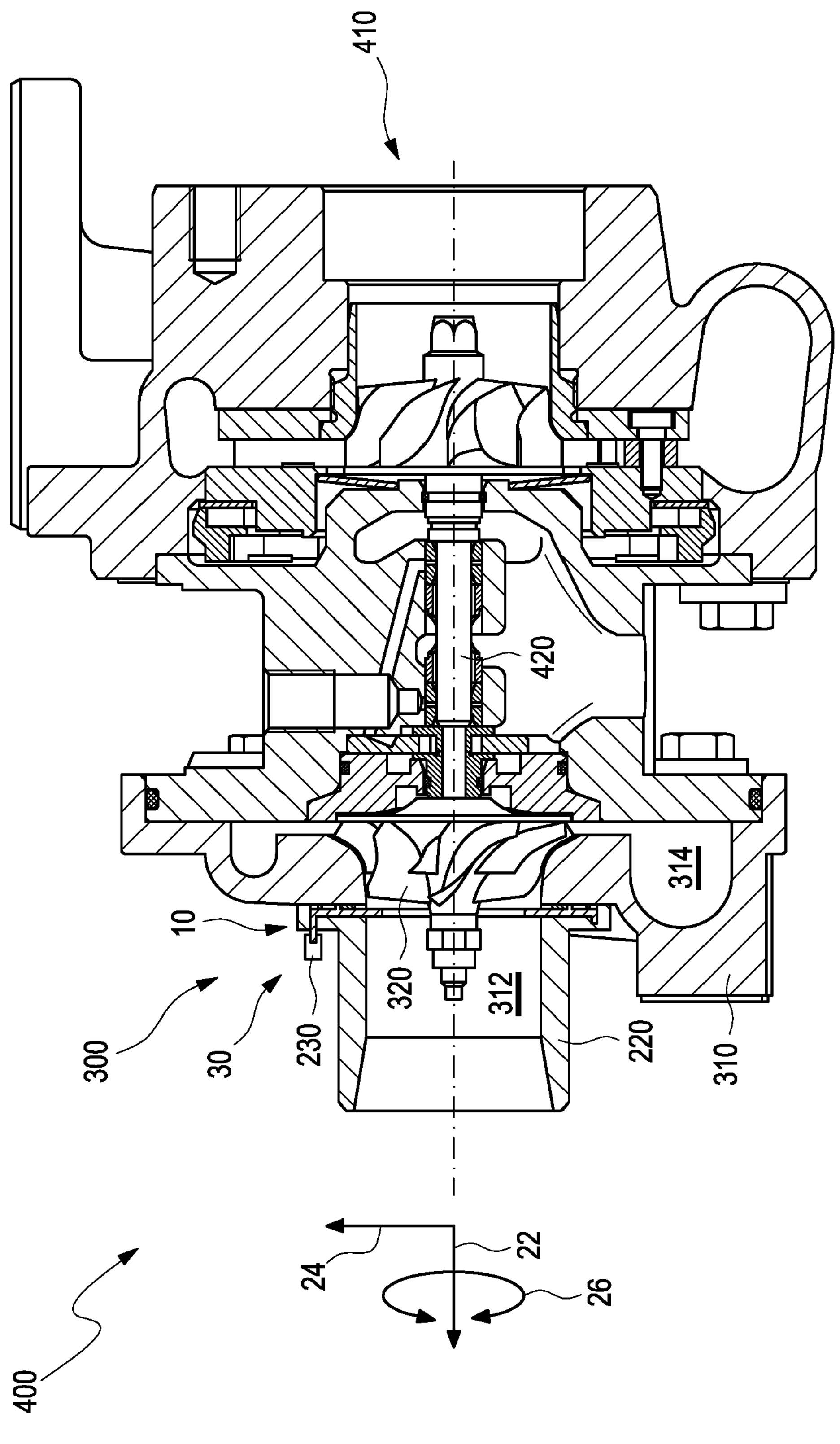


Fig. 1

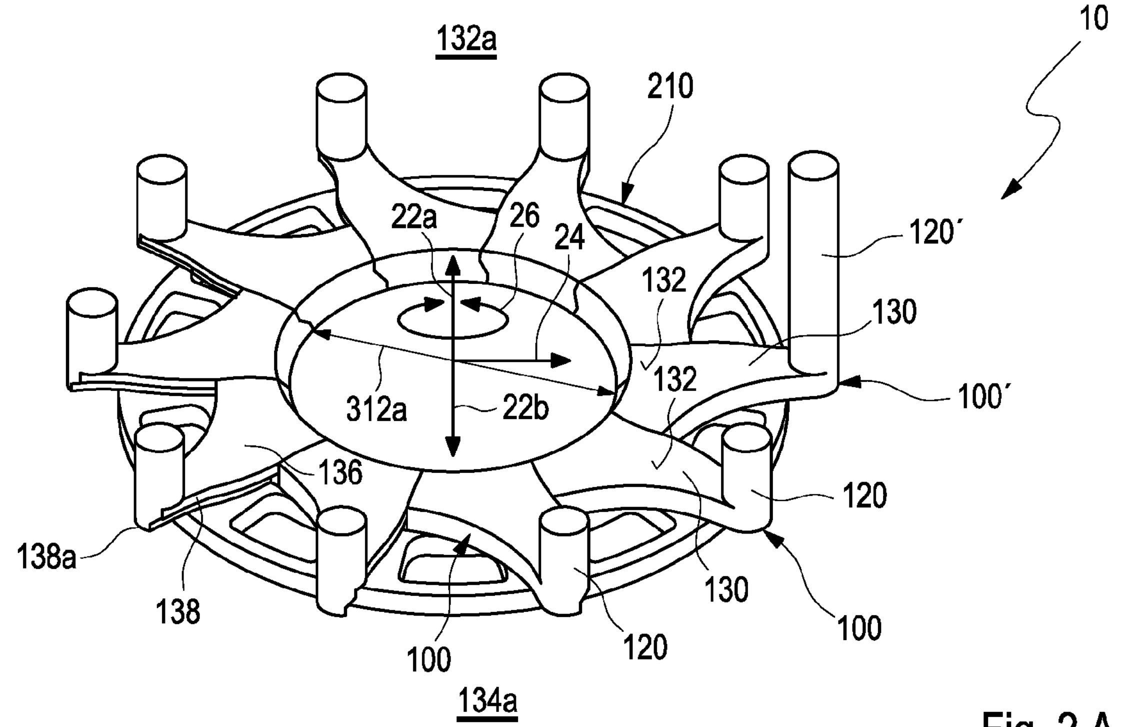
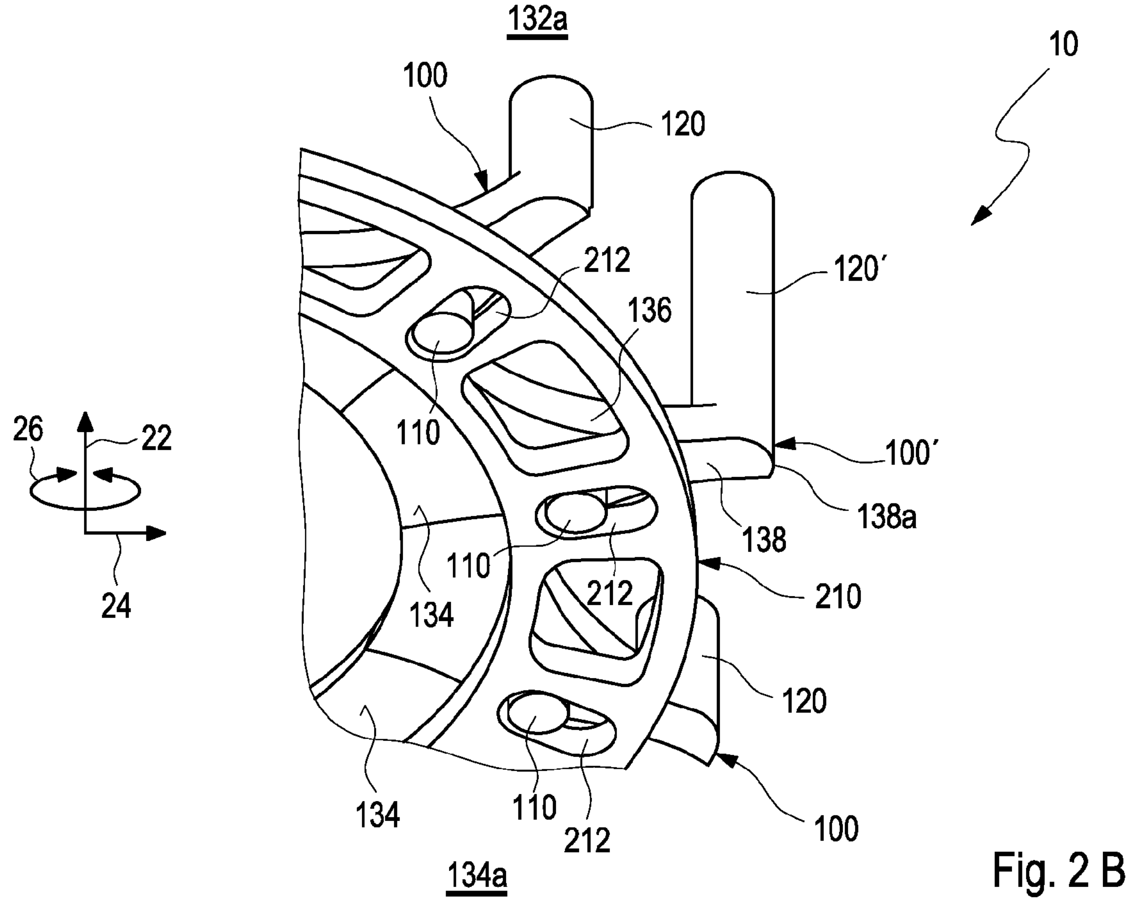

132a
10
210
22a
26
24
120´
132
130
132
312a
22b
100´
136
120
138a
138
130
100
100
120
134a

Fig. 2 A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10
100
120
120´
212
136
110
26
22
100´
138a
138
110
212
210
24
134
120
134
110
212
100
134a

Fig. 2 B

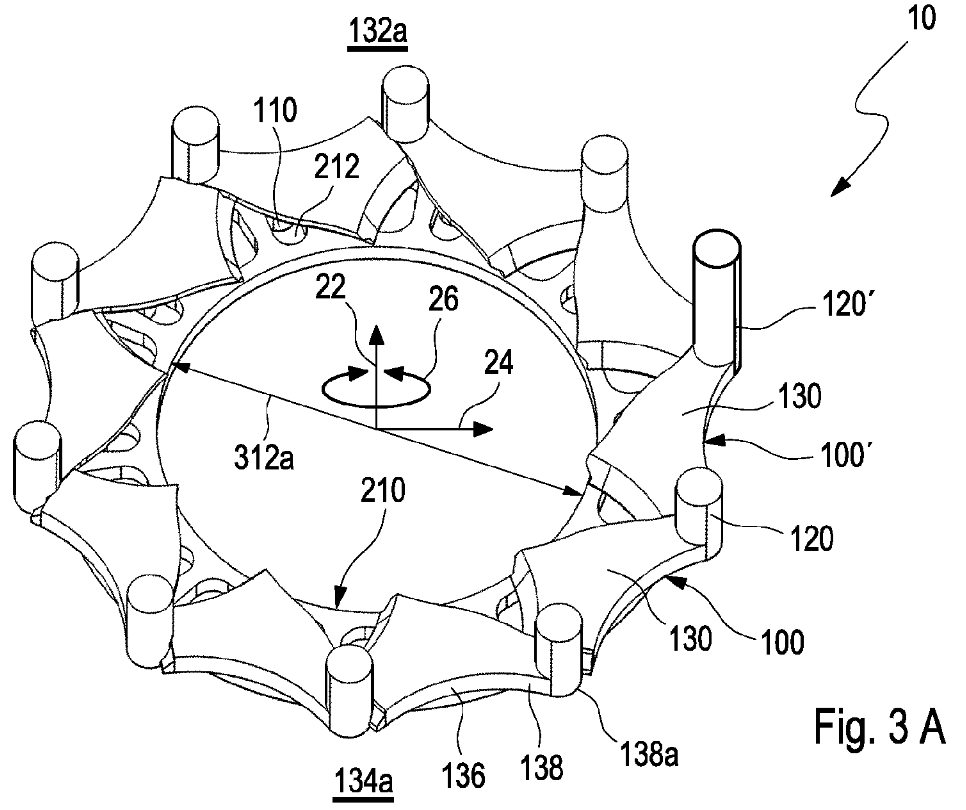

132a
10
110
212
22
26
24
120´
130
312a
100´
210
120
130
100
134a
136
138
138a

Fig. 3 A

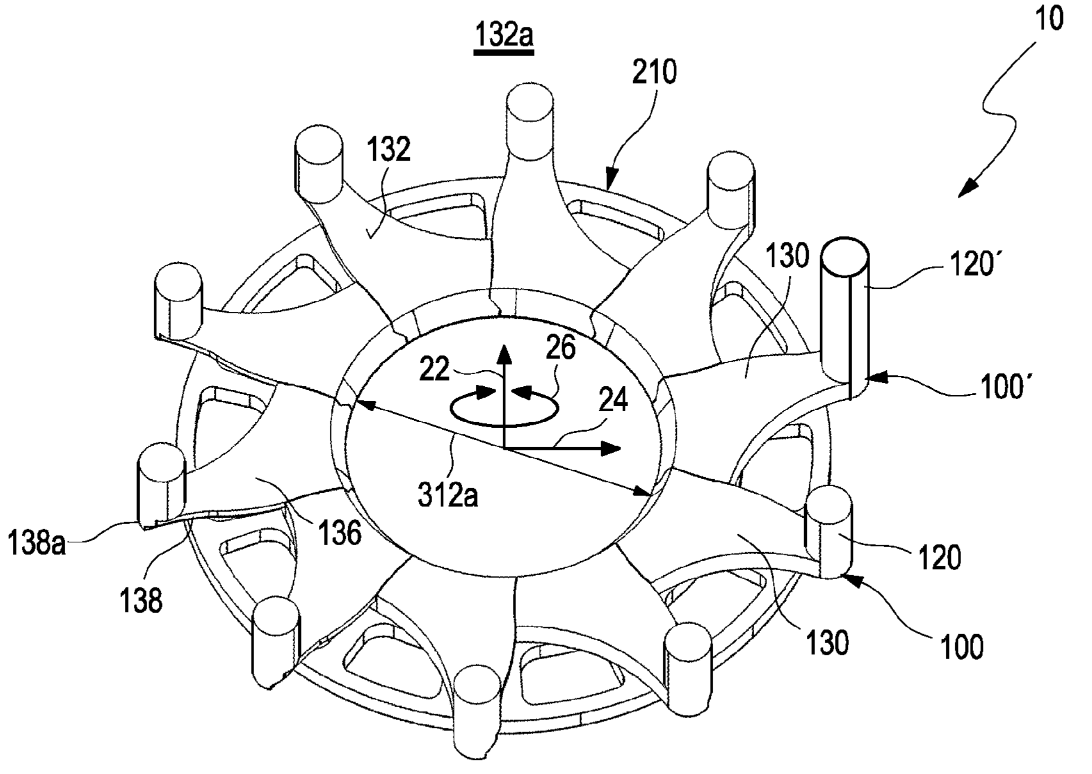
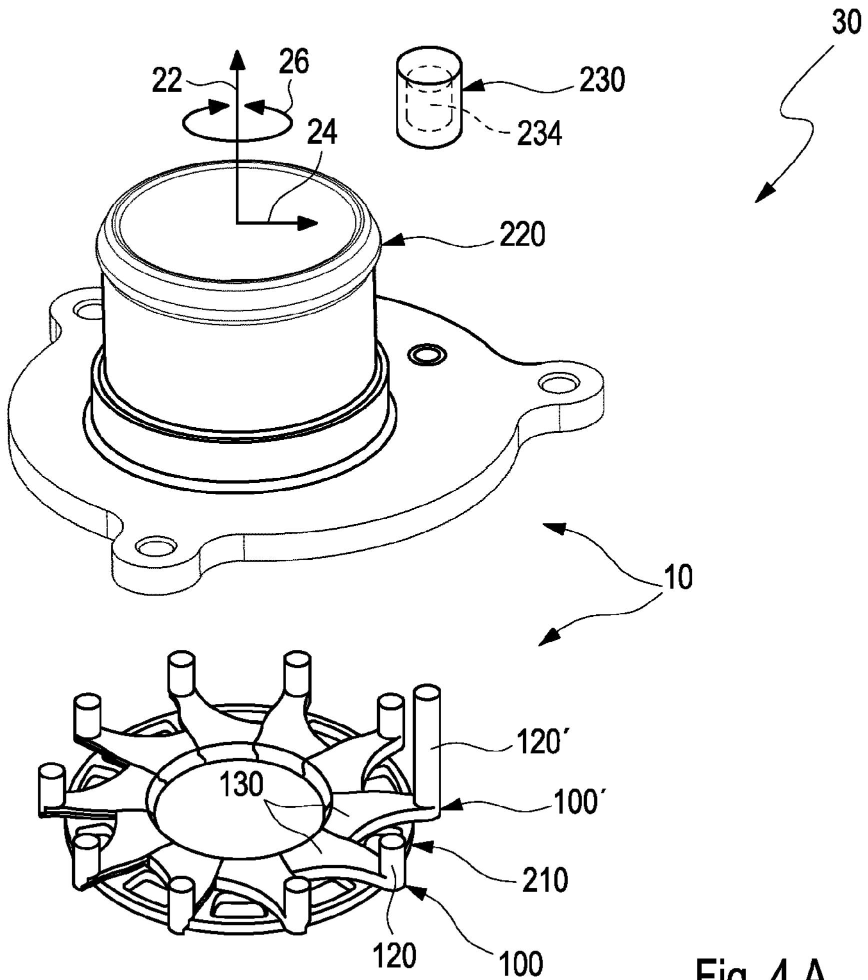

132a
10
210
132
130
120´
22
26
24
100´
312a
138a
136
120
138
130
100
134a

Fig. 3 B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22
26
230
234
24
220
10
120´
130
100´
210
120
100

Fig. 4 A

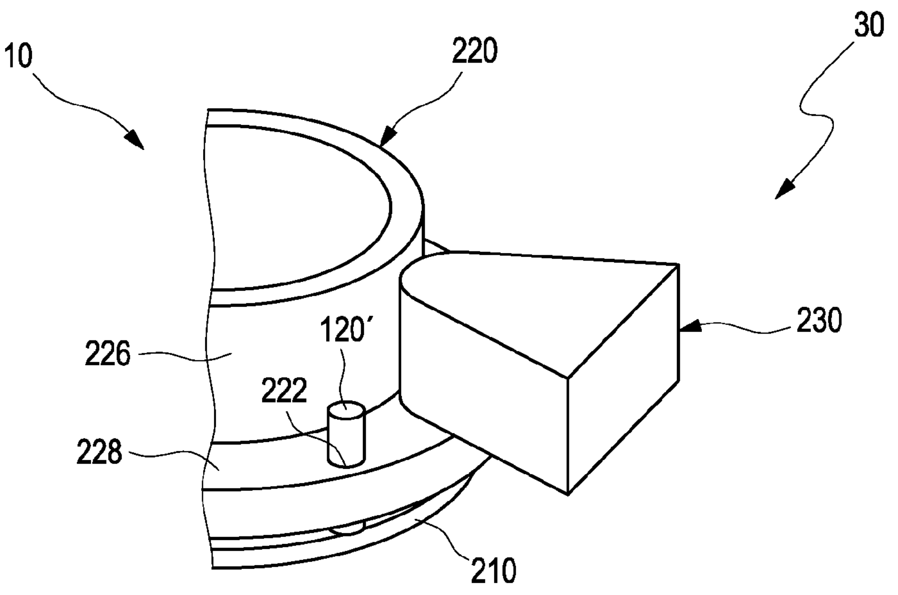
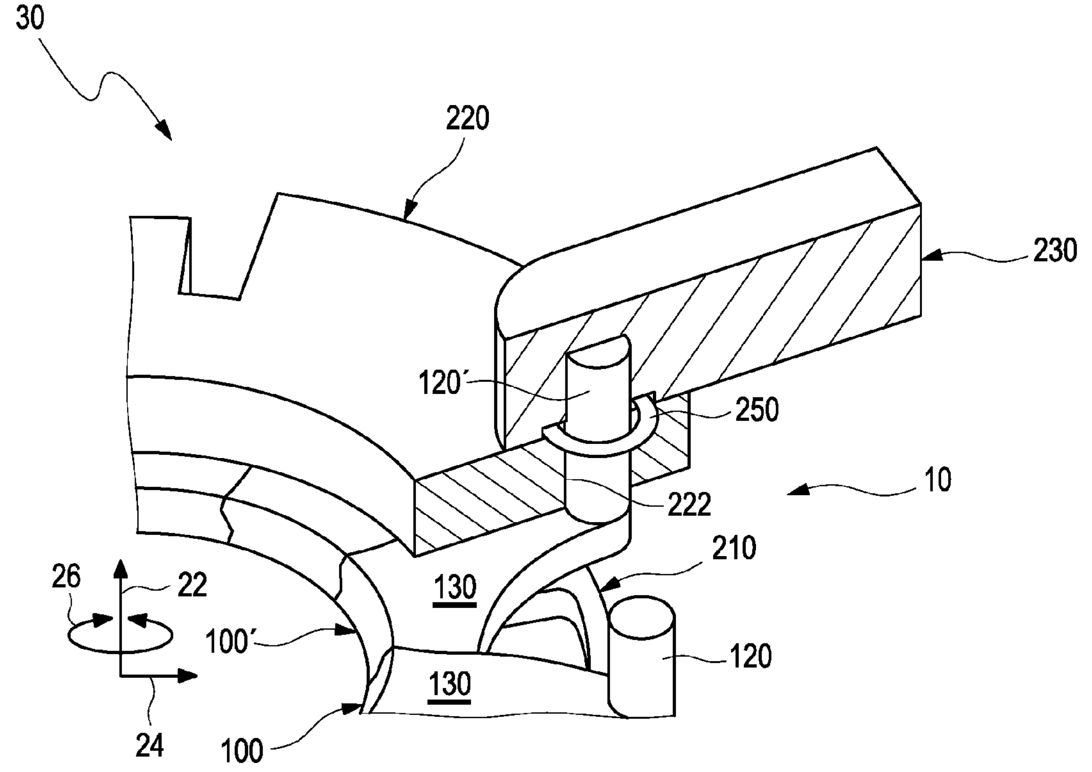

30
10
220
230
226
120´
222
228
210

Fig. 4 B


30
220
230
120´
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10
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26
22
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100´
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Fig. 5 A

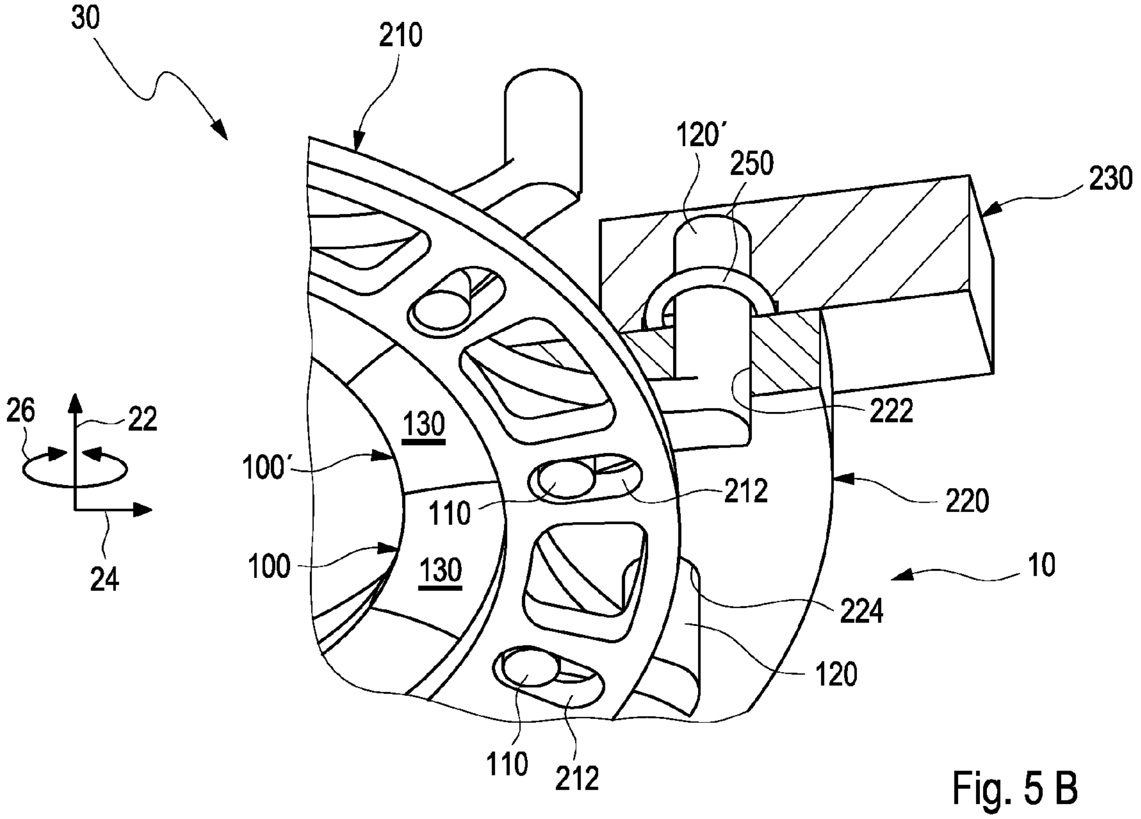
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Fig. 5 B

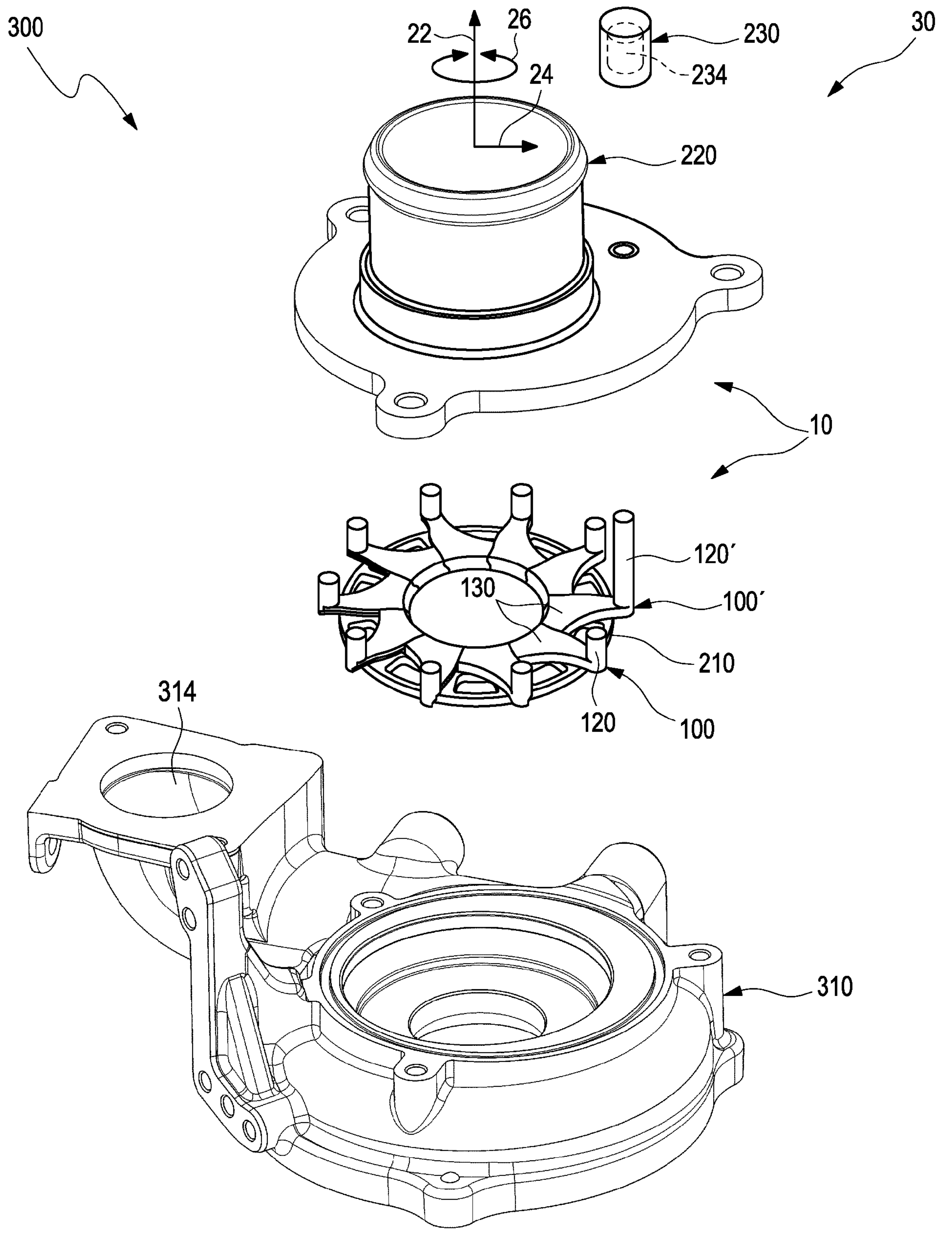

Fig. 6

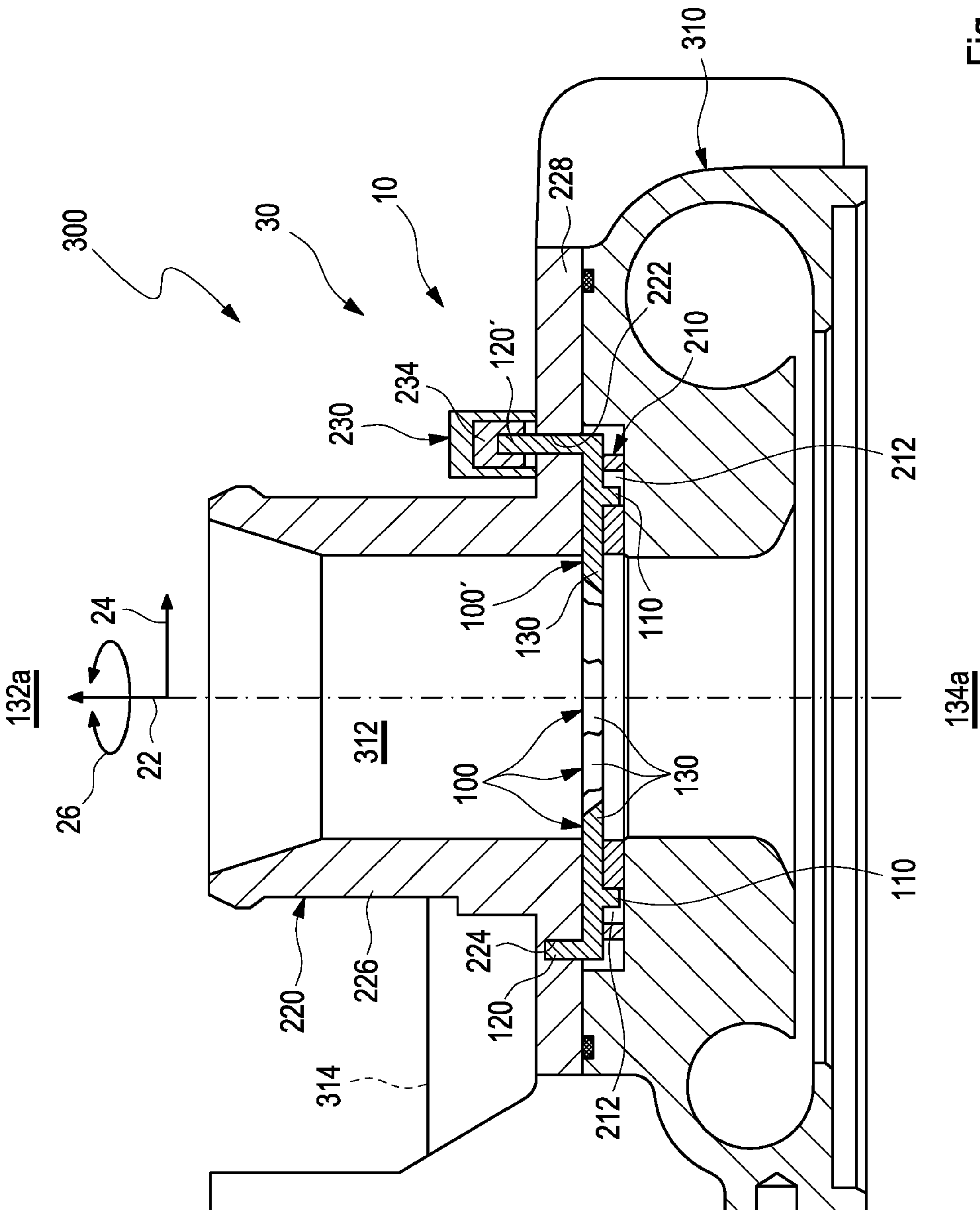
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Fig. 7

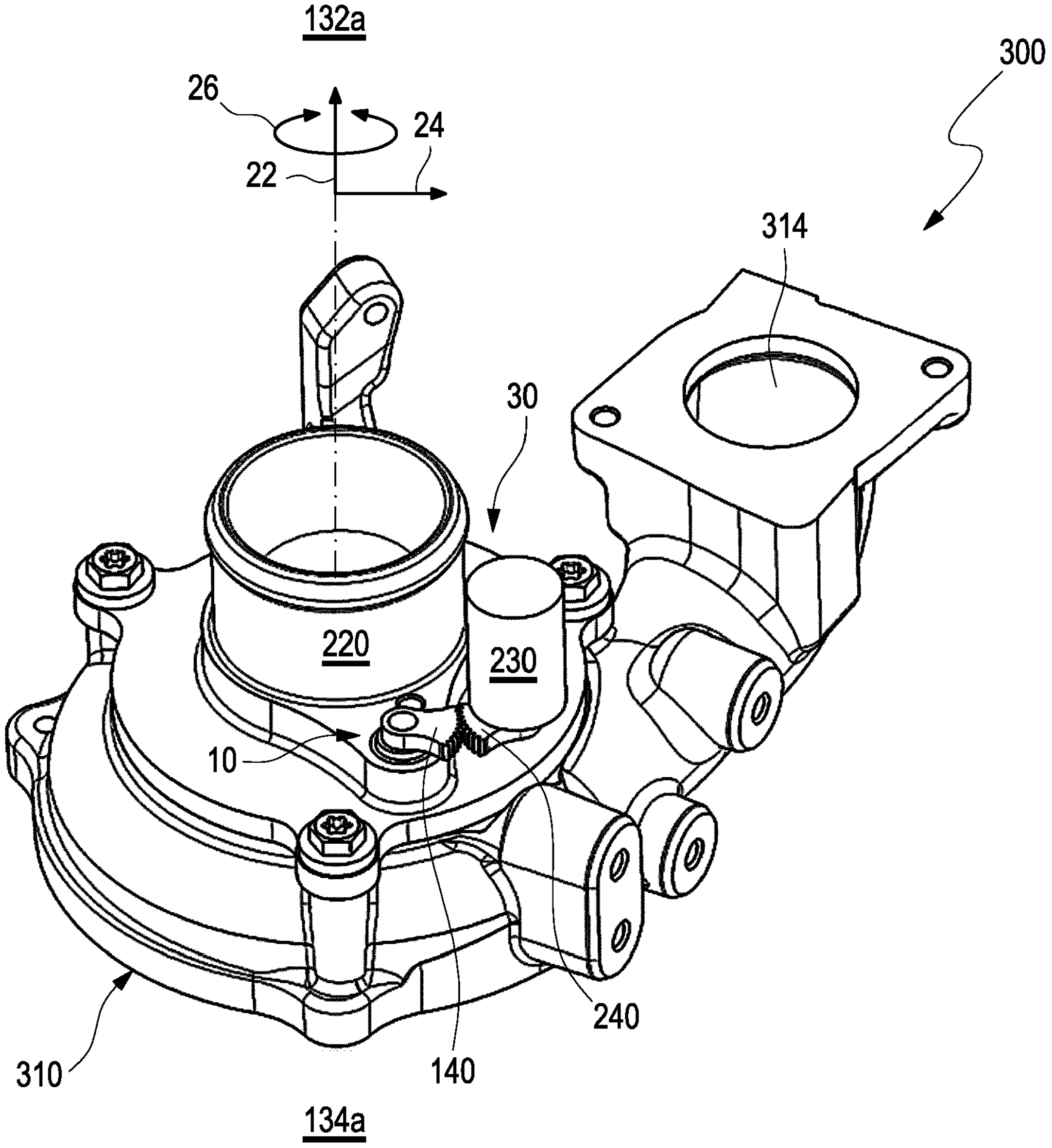

Fig. 8

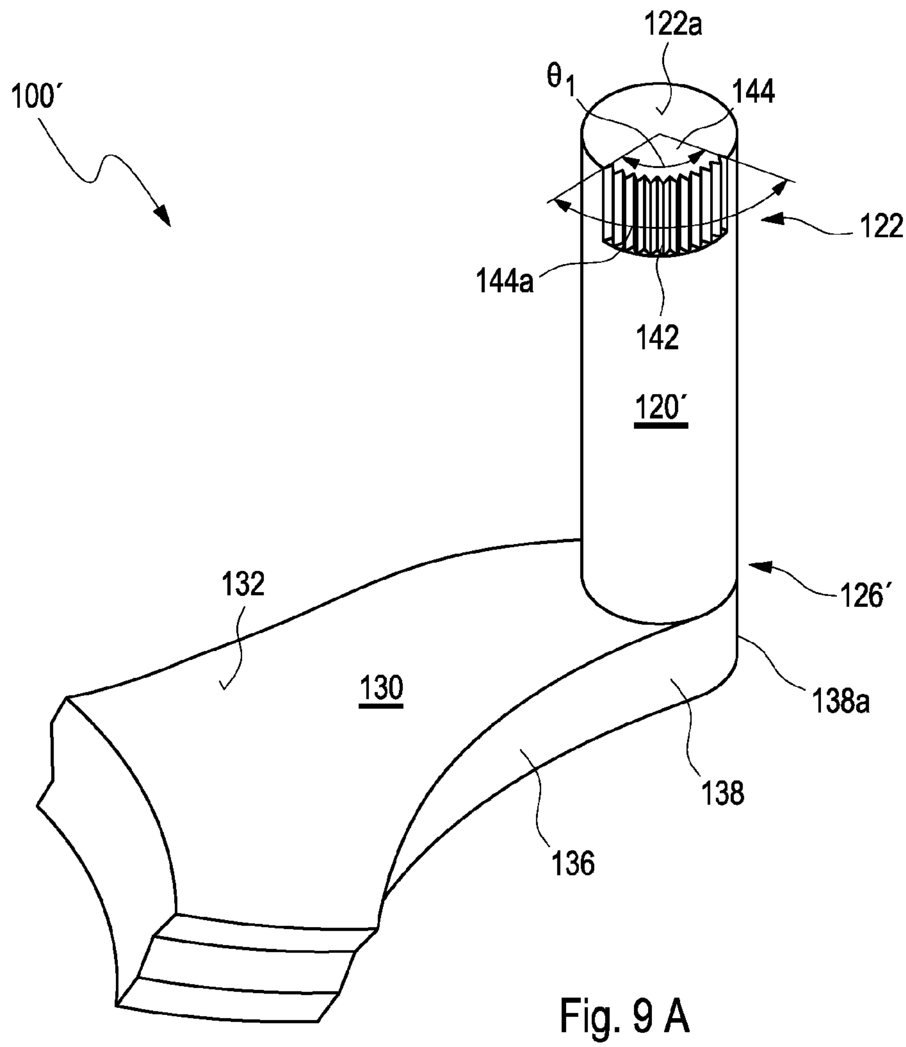

Fig. 9 A

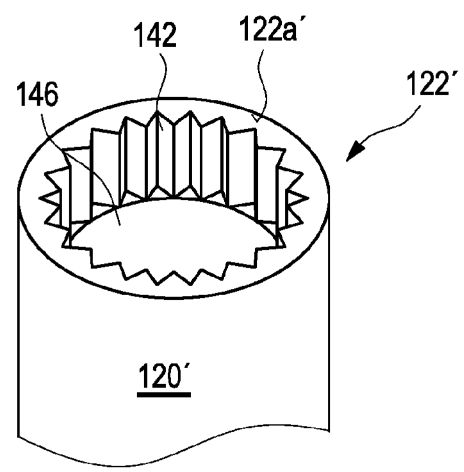

Fig. 9 B

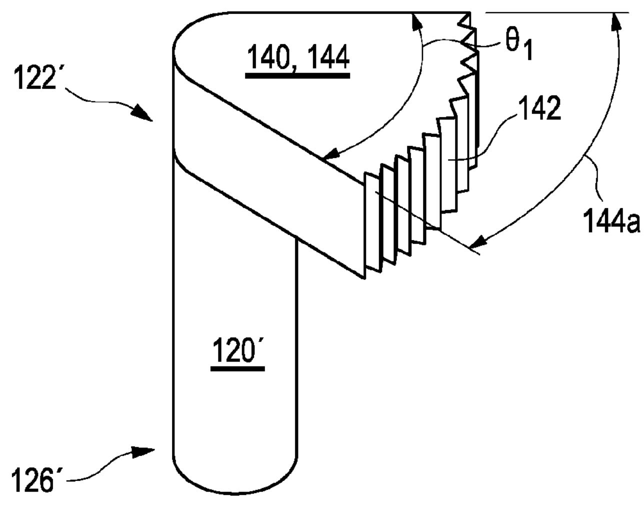

Fig. 9 C

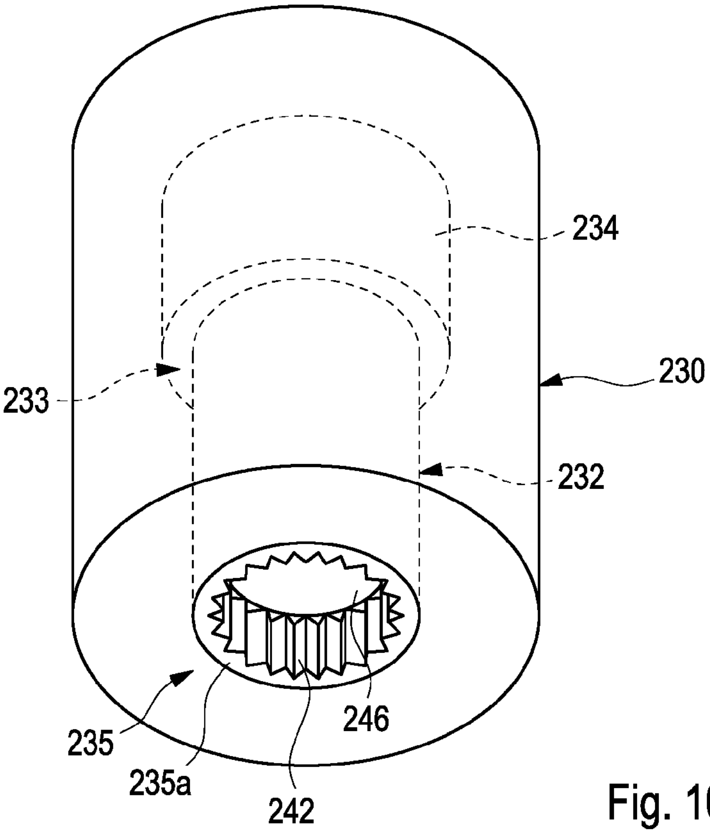

Fig. 10 A

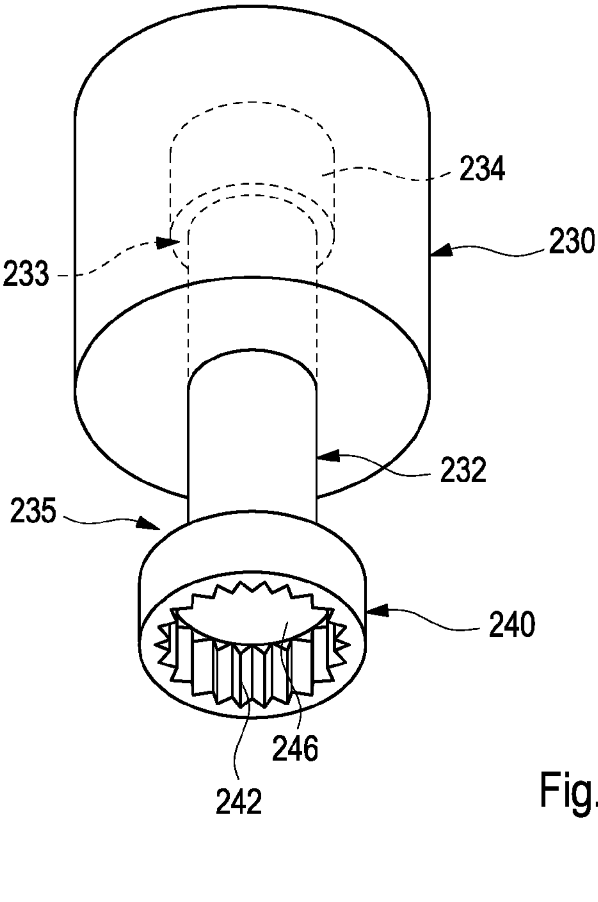

Fig. 10 B

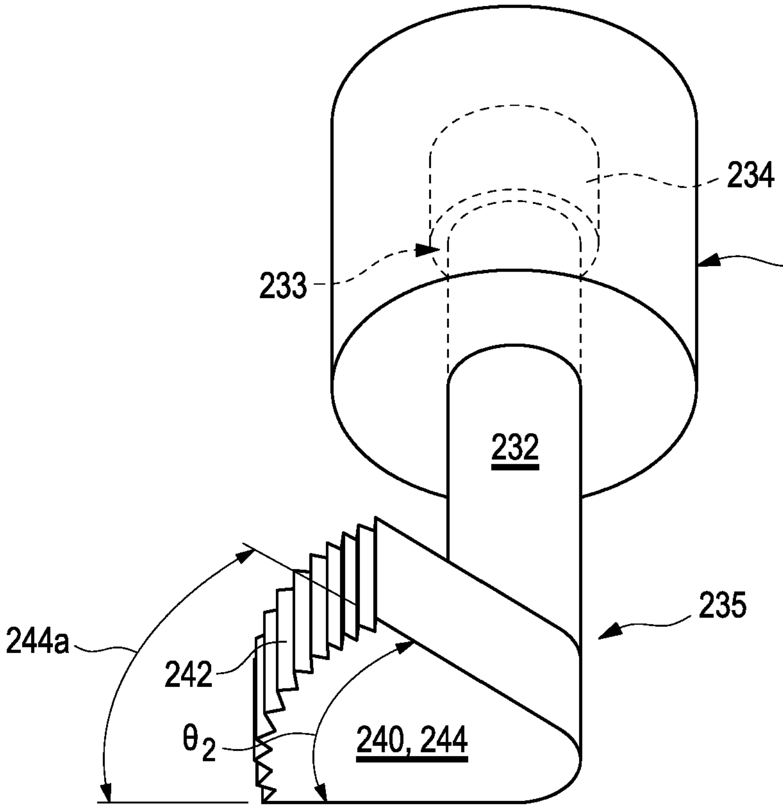

Fig. 10 C

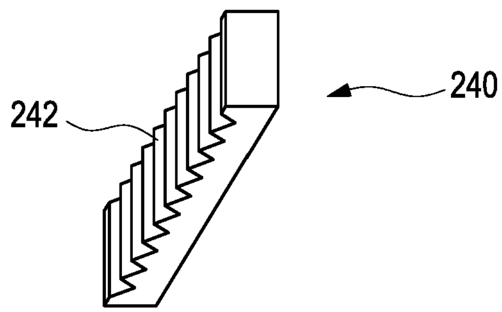

Fig. 10 D

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EUROPEAN SEARCH REPORT

Application Number
EP 19 16 5123

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	EP 3 441 618 A1 (GARRETT TRANSP I INC [US]) 13 February 2019 (2019-02-13) * paragraphs [0014] - [0038]; figures 1-11 * -----	1-5	INV. F04D27/02 F04D29/46
A	WO 2018/045153 A1 (BORGWARNER INC [US]) 8 March 2018 (2018-03-08) * paragraph [0014]; figure 3 * -----	6-15	

TECHNICAL FIELDS SEARCHED (IPC)

F04D
F01D

The present search report has been drawn up for all claims

2

Place of search	Date of completion of the search	Examiner
The Hague	23 September 2019	Nobre Correia, S

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EP 19 16 5123

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23-09-2019

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 3441618 A1	13-02-2019	CN 109386480 A	26-02-2019
		EP 3441618 A1	13-02-2019
		US 2019048876 A1	14-02-2019
WO 2018045153 A1	08-03-2018	CN 108884721 A	23-11-2018
		EP 3507463 A1	10-07-2019
		KR 20190044103 A	29-04-2019
		US 2019195122 A1	27-06-2019
		WO 2018045153 A1	08-03-2018

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